Space Weather Technical Forecast

Issued on Wednesday, 26 April 2023 at 01:30 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: G1/Minor-G2/Moderate Storm risk Days 1-3 (26-28 Apr). Chance of M-class flares (R1-R2 Minor-Moderate radio blackouts) throughout. Chance of Active fluence Day 1 and 4 (26 and 29 Apr).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with only a small number of minor C-class flares observed. There are currently seven sunspot regions on the visible disc.

AR3285 (Cso/Beta) in the southeast quadrant remains the largest region, although appears largely inactive with little change in recent appearance. AR3288 (Dsi/Beta) to the southeast of AR3285 has shown some slight growth in intermediate spots in recent hours suggesting some increase in magnetic complexity. The other region of significance at this time is the newly numbered AR3289 (Dso/Beta) that has recently rotated over the eastern limb in the northern hemisphere. Although there is still significant foreshortening of the region in available imagery, it does appear to be a relatively large bipolar group. The current magnetic classification attributed to the region is tentative until confidence increases with improved viewing angle. AR3286 has faded since the last bulletin and AR3282 has rotated off the visible disc. The remaining sunspot regions are all small and simple at present.

A filament eruption from around 35S 25W beginning around 25/1900 UTC has led to a CME evident in STEREO A imagery. LASCO imagery is currently delayed, however, on first assessment most, if not all of the ejecta appears to be directed southwards and below Earth orbit. This will be confirmed once further coronagraph imagery is available.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by DSCOVR at L1, was initially at slightly elevated levels around 470km/s, but increased to become elevated from around 25/0030 UTC. Winds peaked at 575km/s at 25/0229 UTC before gradually and somewhat erratically easing through the remainder of the period, with winds more generally between 500-550km/s observed. The density has periodically fluctuated between average and above average levels, with a peak of 15ppcc 25/0229 UTC. The IMF (Bt) carried by the solar wind was initially moderate with a peak of 9nT observed at 25/0000 UTC. The IMF became weak since 25/0030 UTC and has remained weak. The north-south component (Bz) was moderately positive at first, but has been largely weakly negative since around 25/1130 UTC. The phi angle has periodically deviated between sectors, starting mostly negative (towards the Sun), but then generally positive (away from the Sun) between 25/0300-1800 UTC, before changing to a negative sector again. Geomagnetic activity has been largely Quiet (Kp 0-2), but with an Unsettled (Kp3) interval 25/1500-1800 UTC.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) has been at background levels throughout. High energy electron flux (greater than 2MeV) as measured at GOES16, has persisted at predominantly moderate levels. The associated 24-hour electron fluence was below the Active threshold on a rising then steady trend, with 1.29e7 integrated pfu observed at 26/0000UTC.

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Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is most likely to remain Low, with a chance of reaching Moderate levels.

Solar Wind / Geomagnetic Activity: A CME associated with a filament eruption on 24 Apr is forecast to have an Earth directed component, arriving either late on Day 1 (26 Apr) or on Day 2 (27 Apr). Another CME resulting from a filament eruption on 26 Apr is awaiting further imagery to determine if it likely to become geo-effective.

Solar winds are currently at elevated levels, but expected to ease on Day 1 to become slightly elevated. The arrival of a HSS from an equatorial coronal hole is anticipated later on Day 1 or on Day 2 with wind speeds eventually increasing to elevated to strong levels. Solar winds should remain at similar levels into Day 3 and 4 (28 and 29 Apr).

Geomagnetic activity is currently Quiet and expected to be at Quiet to Unsettled levels through much of Day 1, until the anticipated HSS/CME arrivals either later Day 1 or on Day 2. Activity is then likely to become Active to G1/Minor Storm, with a slight chance of G2/Moderate Storm intervals on Day 2. Geomagnetic activity is expected to wane during Day 3 and 4 (28 and 29 Apr), most likely returning to Quiet or Unsettled levels.

Energetic Particles / Solar Radiation: High energy (greater than 10MeV) proton flux is expected to continue at background levels. High energy (greater than 2MeV) electron flux is currently at generally moderate levels, with a rise possible on Day 1 (26 Apr) to occasionally High levels, before a probable decline through Days 2 and 3 (27-28 Apr), followed by a possible increase again on Day 4 (29 Apr). Electron fluence is likely to continue to show a steady or slightly rising trend on Day 1, with a chance of reaching Active (1e8 integrated pfu), followed by a decline through Days 2 and 3 (27-28 Apr). An increase may occur on Day 4 following the expected easing of Geomagnetic activity, but with low confidence.

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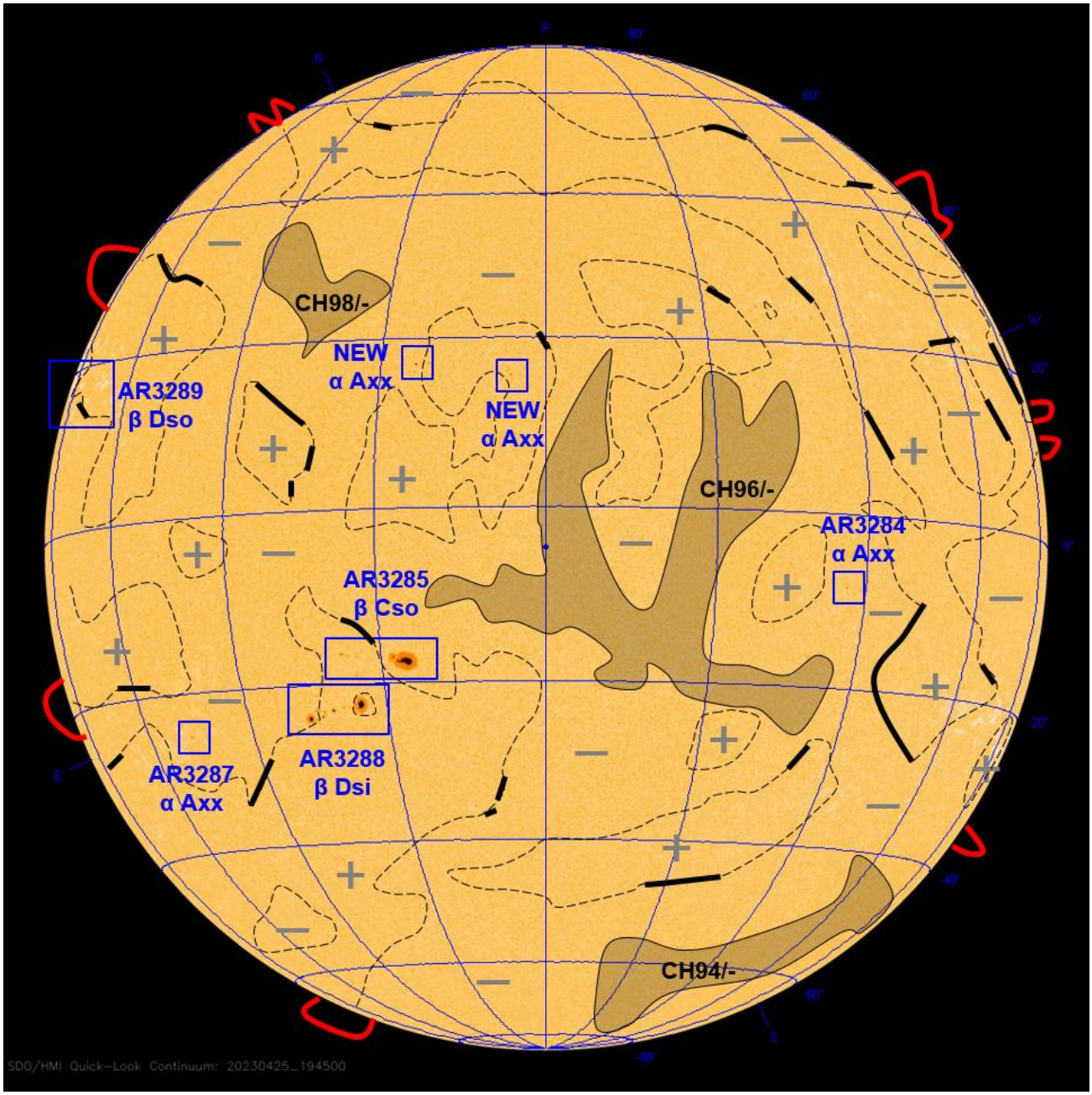
Figure 1. Solar Analysis Valid 25/1945 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A filament eruption occurred from near south centre disc starting around 24/1300 UTC. The CME was observed in coronagraph imagery heading generally south, but an Earth directed component is probable, with this most likely reaching Earth in the first half of Day 2 (27 Apr). Arrival time estimates through ensemble forecasting vary between the very end of Day 1 (26 Apr) and late on Day 2 indicating there is some uncertainty over the timing of this feature passing by Earth.

A further filament eruption from around 35S 25W beginning around 25/1900 UTC led to a CME evident in STEREO A imagery. LASCO imagery is currently delayed, however, on first assessment most, if not all of the ejecta appears to be directed southwards and below Earth orbit. This will be confirmed once further coronagraph imagery is available.

The effects at Earth of the large full halo CME which left the Sun on 21 Apr have largely subsided now, however, solar winds currently remain at elevated levels. Wind speeds are expected to slowly and erratically decline back to slightly elevated levels on Day 1. The HSS from the equatorial CH96/- is likely to arrive at Earth the end of Day 1, similar to persistence and supported by SWFM. The leading edge of this feature is in a similar location to the last rotation, however, it is a broader and better defined feature than last time. Forecast wind speeds of around 550-600 km/s are reasonable and consistent with thinking, with an upper estimate of 650-700km/s possible by Day 2. The strength of the winds in the HSS may be somewhat superseded or masked by the possible arrival of the CME from 24 Apr.

The HSS from CH96/- is expected to continue at Earth into Days 3 and 4 (28 and 29 Apr), perhaps with some slight weakening of the winds later on Day 4, although winds may still be elevated or strong at this time.

Geomagnetic activity is currently Quiet and expected to be at Quiet to Unsettled levels through much of Day 1. The HSS and preceding CIR from CH96/- are likely to be reflected in an increase in geomagnetic activity, with Unsettled or Active intervals (Kp3-4) forecast and a slight chance of G1/Minor Storms (Kp5). The anticipated arrival of a glancing blow from a CME on Day 2 in combination with the HSS, increases the probability of experiencing elevated geomagnetic activity, with G1/Minor Storm conditions likely and a slight chance of a G2/Moderate Storm (Kp 6). In the absence of any further CMEs, activity is expected to wane during Day 3 and 4 (28 and 29 Apr), most likely returning to Quiet or Unsettled levels.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	50	20	5
Strong	G3	No	5	10	5	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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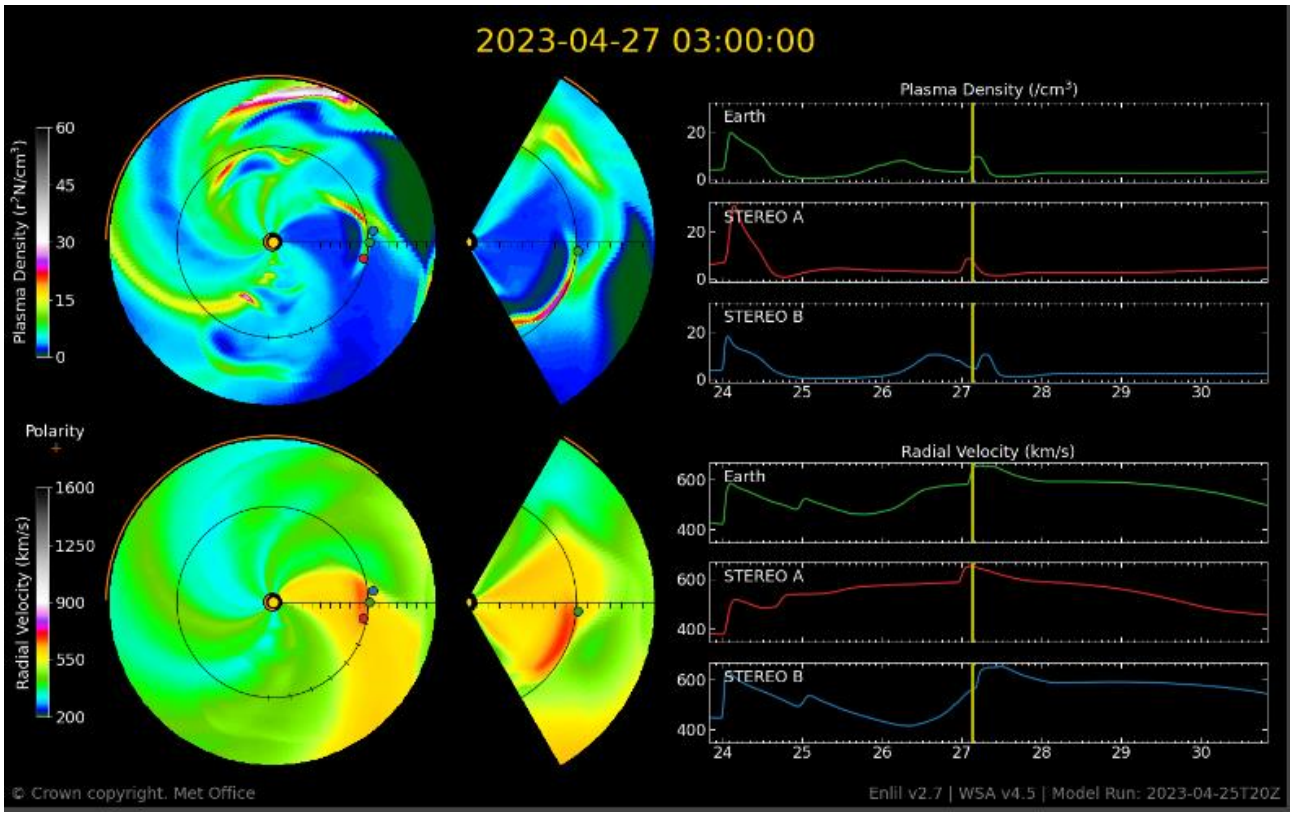
Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
24/1900	Partial	Filament eruption	SW	700 km/s	27/0300 UTC	Glancing blow likely

Figure 2: MOSWOC Enlil output indicating most likely arrival time of CME on 27 Apr. Much of the ejecta expected below Earth orbit.



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Radio Blackouts - X-Ray Flares:

There are currently five numbered sunspot regions and two unnumbered regions on the visible disc.

AR3285 (Cso/Beta) in the southeast quadrant remains the largest region, although appears largely inactive with little change in recent appearance. AR3288 (Dsi/Beta) to the southeast of AR3285 has shown some slight growth in intermediate spots in recent hours suggesting some increase in magnetic complexity. The other region of significance at this time is the newly numbered AR3289 (Dso/Beta) that has recently rotated over the eastern limb in the northern hemisphere. Although there is still significant foreshortening of the region in available imagery, it does appear to be a relatively large bipolar group. The current magnetic classification attributed to the region is tentative until confidence increases with improved viewing angle.

The remaining sunspot regions are all small and simple at present.

Far side imagery indicates some weakly active regions could rotate across the eastern limb during the period, with a possible increase in flare risk. However, until these regions emerge, any increase in flare risk cannot be accurately assessed. Overall solar activity is likely to remain Low, with a chance of becoming Moderate with any isolated M-class flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	20	20	20	20
Very Active	R3 to R5 X Class	No	1	1	1	1

Solar Radiation Storms - (High Energy Protons):

High energy proton flux (greater than 10MeV) is currently at background levels. There is a nominally increased chance of reaching the S1/Minor Storm level or greater during the period considering the ongoing chance for flares from the current sunspot regions on the visible disc.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	3	3	3	3
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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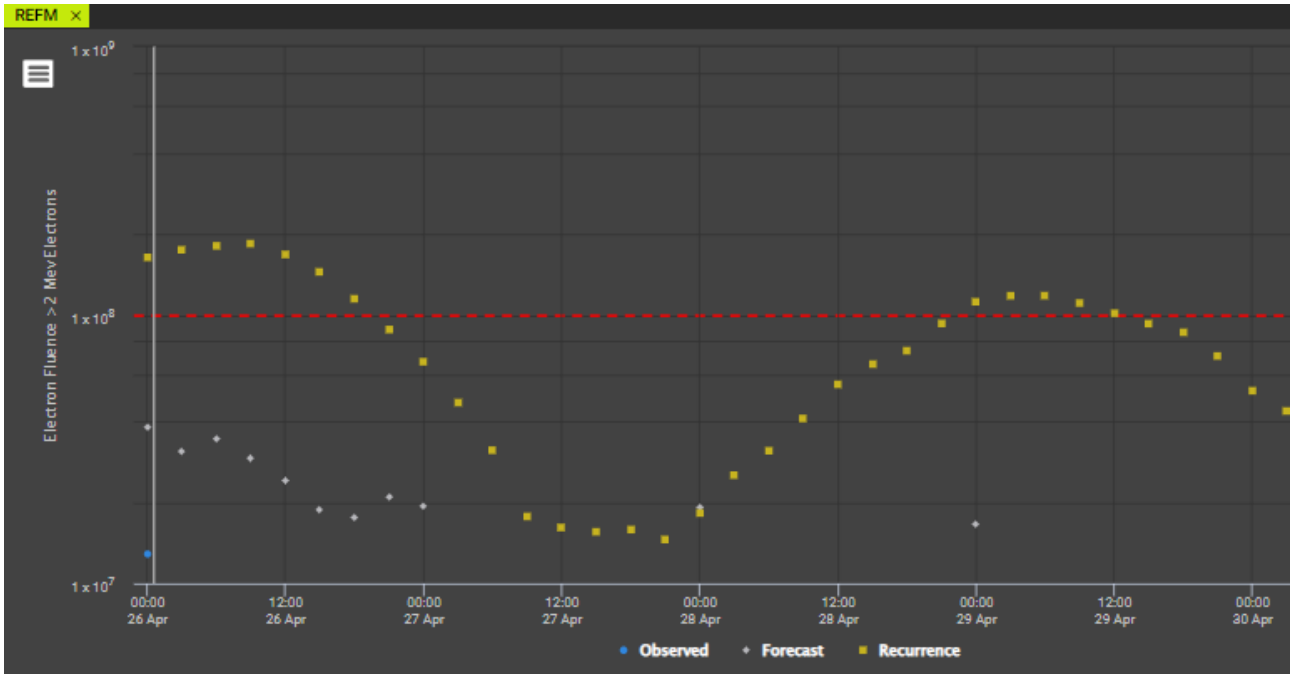
High Energy Electrons Event (≥ 2MeV):

High energy (greater than 2MeV) electron flux remains at predominantly moderate levels. The BAS radiation belt model suggests that electron density has increased in the radiation belt from the recent CME effects. As wind speeds ease during Day 1 (26 Apr), it is likely that the radiation belt will relax towards GEO, carrying the increased density and causing an increase in electron flux at GOES-16. However, the arrival of a HSS from CH96/- and a further probable CME (see Geomagnetic Storm section) from Day 1 into Day 2 (26-27 Apr) is then likely to suppress electron flux levels once more. Flux may reach high levels at the diurnal peak during Day 1 after which time, it is more likely to remain at lower, more background levels until Day 4 (29 Apr), although the end of the period is low confidence at present.

The associated 24-hour integrated fluence is expected to continue to show a steady or slightly rising trend on Day 1, with a chance of reaching Active (1e8 integrated pfu), followed by a decline through Days 2 and 3 (27-28 Apr). An increase may occur on Day 4 following the expected easing of Geomagnetic activity, but with low confidence.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	30	10	10	30
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 3: Latest MOSWOC REFM output.



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